

Model PRM-6

Pulse Rate Meter Technical Manual

01-01-01

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MODEL PRM-6



Figure 1-1. Pulse Rate Meter, Model PRM-6

SECTION I

GENERAL

A. PURPOSE AND DESCRIPTION

The Model PRM-6 Pulse Rate Meter is a general purpose survey meter designed to operate with a variety of scintillation and G-M detectors. Its simplicity of design, flexibility of operating mode, and small lightweight package provide an economical instrument for a wide range of detectors.

Extensive use of integrated circuits, variable high voltage with readout of setting on the meter, two D-cell operation and rugged construction are among its design features.

With the integrated circuits mounted in sockets and all the components mounted to a single printed circuit board, ease of maintenance is part of the package. All calibration controls and test points are accessible while operating with the can removed.

The single range switch with BATTERY check and High Voltage readout positions and easy-to-read meter scale enhance ease of operation.

B. SPECIFICATIONS

1. Readout

a. Meter: Ruggedized with 0-500 counts per minute (cpm), BATTERY OK limits and High Voltage scale. Scale length is 2.38 inches (6 cm).

b. Range: Switch-controlled multipliers of 1, 10, 100, and 1k yield scales of 500, 5k, 50k and 500k cpm.

c. Linearity: Within $\pm 5\%$ of full scale ($\pm 2\%$ typical) when driven with a repetitive signal. Linearity with detector depends on count rate and/or dead time of the detector.

d. Response Time: Continuously variable by a front panel control from 10 seconds to 2 seconds measured to 90% of final meter reading.

e. Speaker: 2 inch dia. attached to instrument can. On-off switch provided.

f. Voltage Coefficient: Meter reading changes less than 2% with battery voltage from 2.2 to 3.1 V.

2. Detectors

a. Any Eberline scintillation or G-M detector.

b. Any scintillation detector with a minimum dynode string impedance of 100 M Ω and a minimum pulse height from the radiation of interest of 25 mV with 1200 V applied. Detector connector must be single coaxial cable type.

c. Any G-M detector with an operating voltage between 500 and 1500 V.

3. Low Voltage Power Supply

a. Batteries: Two D-cells held by internal captive holders.

b. Voltage Requirement: 1.6 maximum to 1.1 minimum volts per cell.

c. Life: Variable depending on cell type, age, temperature, detector type, high voltage setting, etc. Typical life with new cells at room temperature is:

	G-M Detector	Scintillation Detector
CZn cells	350 hr	250 hr
Alkaline	500 hr	300 hr
Mercury	700 hr	500 hr
NiCd (single charge)	200 hr	150 hr

4. High Voltage Supply

a. Range: Variable by a front panel control from about 500 V to more than 1500 V.

b. Readout: High voltage can be read out on the meter. Readout is selected on the range switch. Accuracy of reading is $\pm 10\%$.

c. Voltage Dependence: High voltage will change less than $\pm 3\%$ with battery voltage from 2.2 to 3.1 V.

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5. Environmental

The instrument is operational from 0°F to +140°F (-18°C to +60°C). The battery type limits the low temperature performance because of terminal voltage decrease and internal impedance increase. For prolonged operation at low temperatures, the following criteria are suggested: Mercury - +32°F (0°C); CZn, alkaline or NiCd - 0°F (-18°C).

6. Mechanical

a. Dimensions: Approximately 4 inches wide x 8 inches long x 6-3/4 inches high including handle (10.2 x 20.3 x 17.1 cm).

b. Weight: Approximately 4-1/4 pounds (1.9 kg) including CZn batteries.

SECTION II OPERATION

A. DESCRIPTION OF CONTROLS AND CONNECTORS

1. External (See Figure 1-1)

a. **Switch:** Seven-position rotary switch that turns the instrument OFF, checks BATTERY condition, reads out High Voltage, and selects scale multipliers of 1, 10, 100 and 1k. This number must be multiplied by the meter indication to obtain the proper reading.

b. **Response:** Controls response time of meter to the most desirable compromise between speed and fluctuation for a particular usage.

c. **Reset:** Discharges integrating capacitor, bringing the meter reading to zero rapidly.

d. **High Voltage Adjust:** Controls magnitude of high voltage applied to the detector. Clockwise rotation increases voltage. Meter reading indicates magnitude when selected on the switch.

e. **Detector:** Connection to detector. Mating connector is MHV series coaxial.

f. **Speaker On-Off:** Switch to disable speaker.

2. Internal (See Figure 2-1)

Calibration Controls: One control for each range which individually calibrates the meter reading on that range to agree with the input pulse rate.

B. PREPARATION FOR USE

1. Inspections

The instrument should be checked for physical damage.

2. Connections

Connect the detector to the detector connector.

CAUTION

Use care not to overvoltage the detector. See Section IV for proper set-up with detectors.

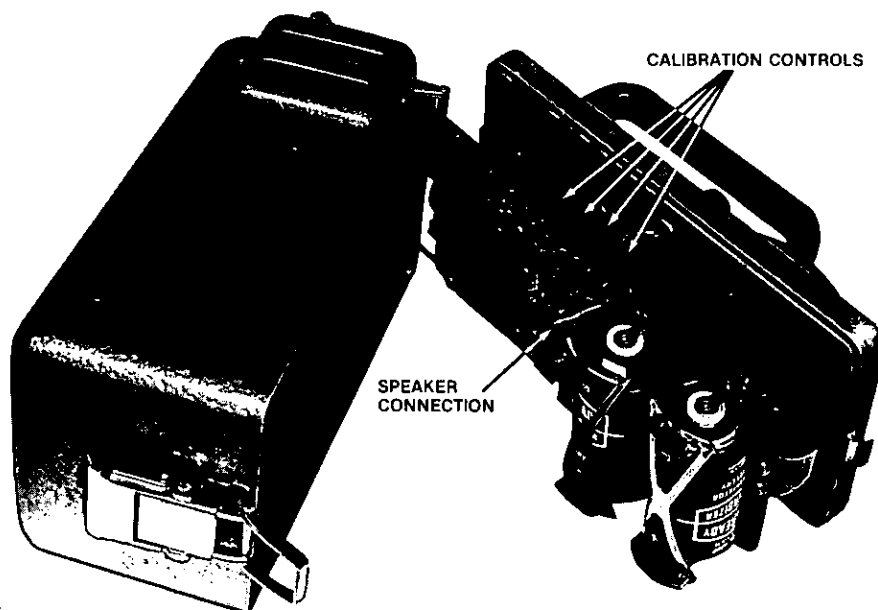


Figure 2-1. Pulse Rate Meter, Model PRM-6, Internal

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C. USING THE INSTRUMENT

1. Starting

a. Turn the switch to the BATTERY check position. The meter should indicate within the BATT OK limits.

b. Turn the switch to the HV position. The meter should indicate the high voltage applied to the detector.

2. Operation Check

Place a check source in a repeatable position adjacent to the detector and move the switch to a range that gives an upscale reading. Note that the reading is sensitive to the

position of the source. The reading may be recorded for future reference.

Push the RESET button and reading should drop to zero rapidly, then climb back to source reading when the RESET is released. The RESPONSE may be adjusted to obtain the most desirable compromise between speed of response and meter fluctuation.

3. Interpretation of Indications

The meter reading must be multiplied by the scale factor to obtain the proper number. The fluctuation of the meter is normal and is caused by the random nature of radioactive decay.

SECTION III

THEORY OF OPERATION

A. GENERAL

The high voltage supply develops the voltage supplied to the detector. When radiation reacts in the detector, a negative pulse is generated. These pulses are coupled into the amplifier and amplified. They are then coupled into the triggers.

Trigger #1 converts the pulses to standard-size pulses of power. These standard pulses are applied to the meter driver which converts them to standard pulses of current, averages this current and drives the meter. Thus, the meter deflection is proportional to the average rate of radiation at the detector.

Trigger #2 converts the pulses to a width that gives optimum sound from the speaker.

B. FUNCTIONAL THEORY (See Figure 3-1 and 6-1)

1. High Voltage Supply

The oscillator transistor Q10 drives the transformer primary and gets its feedback from the orange-red winding. The voltage is stepped up by the transformer secondary and voltage tripler circuit in the 10417-C01 assembly.

The voltage at the violet lead is divided by R35 through R39 and R40 through R42, so the voltage on the base of Q14 is proportional to the high voltage. This high voltage appears on the control side of a differential amplifier (Q13 and Q14), with the reference side tied to the High Voltage adjust pot that is connected to the stable 1.2 V supply. If the two bases (Q13 and Q14) are not equal, the difference will be amplified (Q11 and Q12) and will change the level of the oscillator which changes the high voltage until they are equal.

Transistors Q15, Q16 and Q17 (part of A4) are connected as a current source for the differential amplifier. They are referenced to a negative voltage developed by the transformer primary, rectified by CR4 and filtered by C13.

When the selector switch (S1) is in the High Voltage position, R42 is replaced by the meter which reads the current in the reference string and is displayed on the meter as high voltage.

2. Amplifier

Transistors Q1 and Q2 form a feedback-controlled preamplifier which amplifies the negative pulses from the detector. The feedback enhances stability, and biasing on Q1 protects from overdrive. Q3 is biased close to cut-off

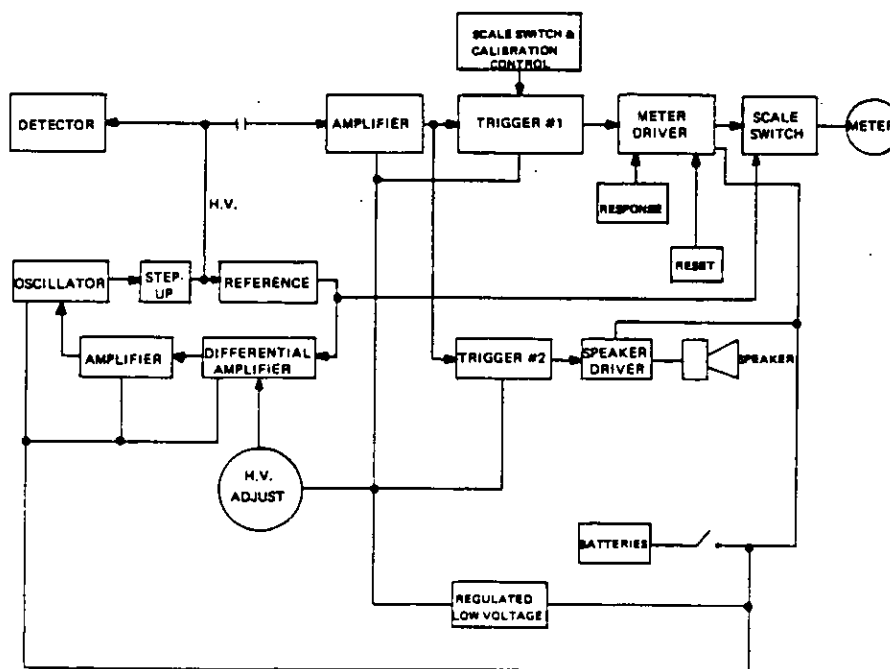


Figure 3-1. System Block Diagram

so its output is near 0 volts. A pulse turns it on and the resulting positive output pulse starts the trigger circuits.

Transistors Q1 and Q2 are part of integrated circuit A1.

3. Triggers

Integrated circuit A2 is a quad 2 input gate connected to operate as two individual monostable multivibrators. Trigger #1 (pins 5 through 10) controls the pulse width for the ratemeter circuit. Trigger #2 (pins 1-3 and 12-14) control the pulse width for the speaker circuit.

a. Trigger #1: The pulse width is controlled by the RC time constant between its pins 7 and 8. This time constant is established by the setting of S1 (scale selection) which selects a particular R and C. The calibration controls form the R for each scale, making the pulse width continuously variable for calibration.

When the trigger is initiated by the pulse from Q3, the output (pin 5) goes positive and holds until the predetermined time (RC) elapses.

b. Trigger #2: The pulse width is controlled by the RC time constant (R20 and C10) between pins 14 and 1. This pulse width is fixed for an optimum duty cycle and sound from the speaker.

When the trigger is initiated by the pulse from Q3, the output (pin 3) goes positive and holds until the RC time elapses.

4. Meter Driver

The driver transistor Q5 is normally off, so no current flows through M1. When the trigger is on, Q4 turns on and also turns on Q5, so current flows thru M1. The amount of current is determined by the voltage across R18. The length of time that current flows is determined by the pulse width of the trigger. This (current times time) forms a certain charge which is transferred to C9 for each event counted. C9 discharges through M1, yielding a certain average current dependent on the rate of input pulses. Changing the pulse width of the trigger (i.e., changing scales or calibration pot setting) changes the average current for a given input pulse rate. This allows the meter to be calibrated to read in counts per minute from the detector.

The response of M1 is controlled by the RC time constant of C9 and R19, the RESPONSE control. With R19 set to a low resistance, the time constant is fast, and at a high resistance it is slow.

To make the meter reading independent of battery voltage, Q4 is operated as a current source. Diode CR2 compensates the meter driver for temperature variations.

Transistor Q4 is part of integrated circuit A1.

5. Speaker Driver

Transistor Q6 inverts the pulse from trigger #2 and provides the base drive for Q7 which drives the speaker. Diode CR3 clips the inductive kick of the speaker.

SECTION IV MAINTENANCE

A. DISASSEMBLY AND REASSEMBLY

1. Batteries

The batteries are secured in captive holders on the etched board. The holding straps may be removed by hand, but a small screwdriver facilitates removal. Pull the batteries from the holder. Replace by sliding batteries into holders, making certain they are centered and of the correct polarity. Replace holding straps.

2. Etched Board

The etched board and cover may be separated for troubleshooting. Proceed as follows:

- a. Remove batteries to prevent electrical damage during disassembly.
- b. Remove knob and mounting nut from scale switch.
- c. Remove two screws that secure meter to circuit board.
- d. Separate board and cover without putting undue stress on wires.
- e. For troubleshooting, place jumpers from meter studs to corresponding points on board and replace batteries.
- f. Reassemble in reverse order of disassembly.

B. PREVENTIVE MAINTENANCE

1. Keep the instrument clean and dry.
2. Replace batteries when their check reading is below the acceptable level.
3. Remove batteries if the instrument is to be inactive for a long period.

C. CALIBRATION (See Figure 2-1)

1. **Ratemeter:** The PRM-6 is calibrated so that the meter reads the same number of pulses per minute that are being counted.

Using a variable frequency pulse generator and oscilloscope or Eberline Model MP-1 connected to the detector connector, calibrate each range as follows:

CAUTION

The frequency generator used may be damaged unless the high voltage is turned down low enough to prevent an over-voltage on the generator. To be sure, use a capacitor of sufficient voltage rating to couple the generator to the instrument (i.e., 0.01 μ F at 2 kV).

NOTE

Frequency generator must provide a negative output of at least 25 mV amplitude with a 1 μ second risetime.

- a. Set pulse generator to 400 cpm.
- b. With selector switch on X1, calibrate for 400 on meter.
- c. Repeat for 4k cpm (X10); 40k cpm (X100), and 400k cpm (X1000).

2. High Voltage Adjustment (See Figure 1-1)

CAUTION

The High Voltage supply may have voltage capability exceeding the detector rating. DO NOT turn the High Voltage ADJ to maximum without observing the voltage rating or observing either noise or plateau.

a. G-M Detectors

Turn the detector switch to High Voltage and adjust the meter to the voltage rating of the detector.

b. Scintillation Detectors (See Figure 4-1)

The proper setting for the high voltage is to operate on the detector plateau below the threshold of noise or unwanted radiation. This setting is best determined as follows:

- (1) Plot a plateau (cpm vs high voltage) with the detector counting the type of radiation of interest.

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(2) Plot a second plateau with the detector counting the type of radiation to be rejected (i.e., gamma for an alpha detector).

(3) From the two plateau curves a voltage is picked and the instrument adjusted to that voltage.

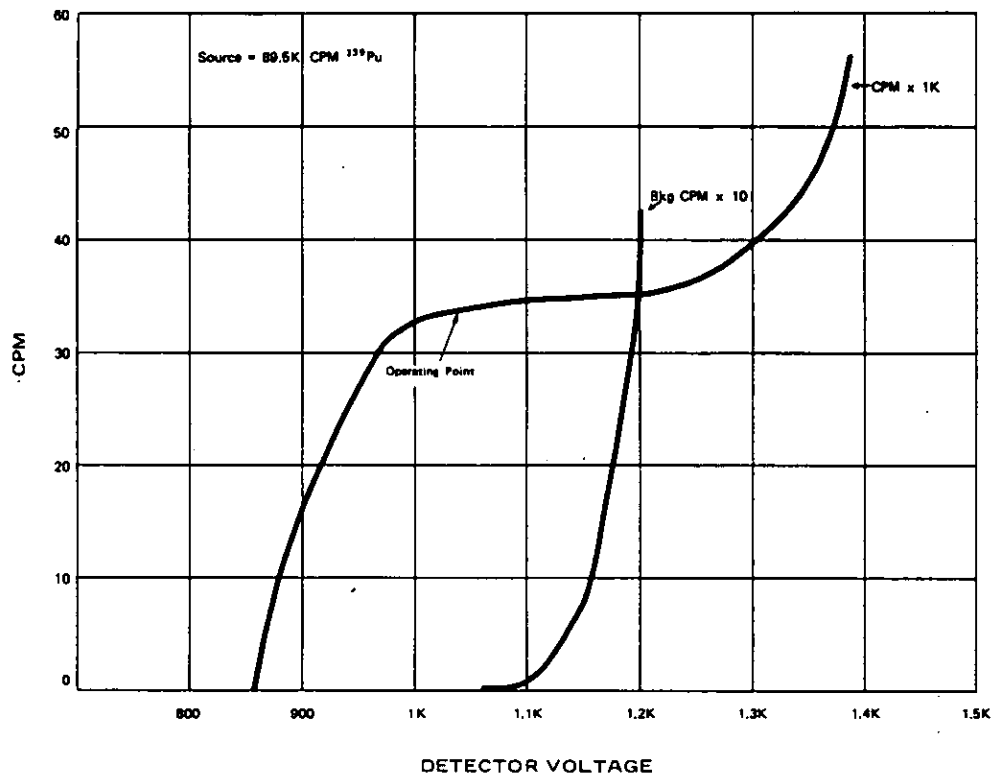


Figure 4-1. Typical Plateau, Model PRM-6 with AC-3

SECTION V PARTS LIST

The following table lists the electronic items incorporated in the PRM-6 and should contain any part necessary for normal repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only, and not restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
1. Speaker Assembly (ZP10652006)				
	Seal			ZP10460019
DS1	Speaker	2-inch diameter, 8 Ω , 0.1 W	Lafayette No. SK-189 or Olsen No. S-433	ADSP3
P2	Crimp Lug	Faston 100 Series	AMP No. 61060-1	TEQC2
S3	Switch	SPST	Alco MTA-106D	SWTO12
2. Cover				
J1	Connector	MHV	Amphenol No. 27025	CXMH2
J1-A	Adapter	Angle, MHV	Amphenol No. 10425	CXMH1
M1	Meter	20 μ A dc with 10472-B111 Face	Triplett 321 HR Special	MTPA7
R19	Potentiometer	RESPONSE, RV-6 style, 10k; linear	CTS Series 300 or equivalent	PTCC103B43
R25	Potentiometer	HV ADJUST, 10k, linear taper	RV-6 LAYSA103A	PTCC103B23
S2	Switch	RESET	Grayhill No. 30-1	SWPB5
	Knob	RESPONSE	Raython No. G50-1-1	ZP10031117
3. Electronics Board (YP10652002)				
		Transformer Assembly	Eberline 10931-00	
A1, A4	Integrated Circuit	Transistor Array	RCA-CA3046	ICRTACA3046
A2	Integrated Circuit	Quad 2-input NOR gate	MOT MC-717P or MC817P	ICRTA0817P
A3	Integrated Circuit	Voltage Reference, 1.2 V, 5%	National LM113H	ICAVC0113H
C1	Capacitor	220 pF, 3 kV	CRL No. DD-30-221	CPCE221P3Y
C2	Capacitor	0.01 μ F, 80 V	Sprague 192P1039R8	CPPF103P3O
C3, C4	Capacitor	0.001 μ F, 200 V	Sprague 192P10292	CPPF102P3R

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REF. DESIG.	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
3. Electronics Board (continued)				
C5	Capacitor	0.68 μ F, 35 V	CS13 Case A	CPTA684P3L
C6	Capacitor	0.068 μ F, 35 V	CS13 Case A	CPTA683P3L
C7	Capacitor	0.0068 μ F, 80 V	Sprague 192P6829R8	CPPF682P3O
C8	Capacitor	0.00068 μ F, 200 V	Sprague 192P68192	CPPF681P3R
C9, C12	Capacitor	330 μ F, 6 V, 20%	CS13 Case D	CPTA331M3D
C10	Capacitor	0.1 μ F, 35 V	CS13 Case A	CPTA104P3L
C11	Capacitor	120 μ F, 10 V	CS13 Case C	CPTA121M3F
C13	Capacitor	120 μ F, 15 V, 10%		CPTA121M3H
C14	Capacitor	0.1, 80 V	Sprague 192P-1049R8	CPPF104P3O
C15	Capacitor	10 μ F, 10 V	Mallory CMT 106M100P1D	CPTA100M3F
C16	Capacitor	0.33 μ F, 15 V, 20%	CS13 Case A	CPTA334P3L
C17	Capacitor	0.47 μ F	CS13 Case A	CPTA474P3L
CR1, CR2, CR3	Diode		1N4148	CRSI1N4148
CR4	Diode		1N4001	CRSI1N4001
J2		Faston 110 Series	AMP No. 61134-1	TEQC3
Q3, Q5, Q12	Transistor		2N4126	TRSP2N4126
Q7	Transistor		2N4403	TRSP2N4403
Q10	Transistor		2N3427 or 2N3428	TRGP2N3427
Q11	Transistor		2N4124	TRSN2N4124
R1	Resistor	390k, 1/4 W, 10%		RECC394B22
R2	Resistor	8.2k, 1/4 W, 10%		RECC822B22
R3	Resistor	15k, 1/4 W, 10%		RECC153B22
R4, R42	Resistor	3.9k, 1/4 W, 10%		RECC392B22
R5	Resistor	3k, 1/4 W, 5%		RECC302B22
R6, R7, R21	Resistor	3.3k, 1/4 W, 10%		RECC332B22
R8	Resistor	24k, 1/4 W, 5%		RECC243B22
R9	Resistor	27k, 1/4 W, 10%		RECC273B22
R10	Resistor	2.2k, 1/4 W, 10%		RECC222B22
R11	Resistor	2.7k, 1/4 W, 10%		RECC272B22
R12, R13, R14, R15	Potentiometer	10k (Cal)	CTS Type x HT 2014103B, No. RR9167 (Preferred) or Mallory MCT	PTCC103B02
R16	Resistor	470, 1/4 W, 10%		RECC471B22
R17	Resistor	820, 1/4 W, 10%		RECC821B22
R18	Resistor	220, 1/4 W, 10%		RECC221B22
R20	Resistor	6.8k, 1/4 W, 10%		RECC682B22
R22	Resistor	4.7k, 1/4 W, 10%		RECC472B22
R23	Resistor	270, 1/4 W, 10%		RECC271B22
R24	Resistor	330, 1/4 W, 10%		RECC331B22
R26	Resistor	169k, 1/4 W, 1%		RECE164B12

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REF. DESIG.	PART	PART NUMBER	MANUFACTURER AND PART NUMBER	EBERLINE
3. Electronics Board (continued)				
R27	Resistor	680, 1/4 W, 10%		RECC681B22
R29	Resistor	100k, 1/4 W, 10%		RECC104B22
R30	Resistor	100, 1/4 W, 10%		RECC101B22
R31, R43	Resistor	1k, 1/4 W, 10%		RECC102B22
R32	Resistor	68k, 1/4 W, 10%		RECC683B22
R33	Resistor	47k, 1/4 W, 10%		RECC473B22
R34	Resistor	33k, 1/4 W, 10%		RECC333B22
R35, R36, R37, R38, R39	Resistor	22M, 1/4 W, 5%		RECC226B22
R40	Resistor	30k, 1/4 W, 5%		RECC303B22
R41	Resistor	43k, 1/4 W, 5%		RECC433B22
S1	Switch		Eberline 10652-B09	SWRO37

SECTION VI

DIAGRAMS

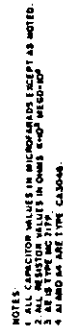


Figure 6-1. Model PRM-6 General Schematic (10652-D11H)

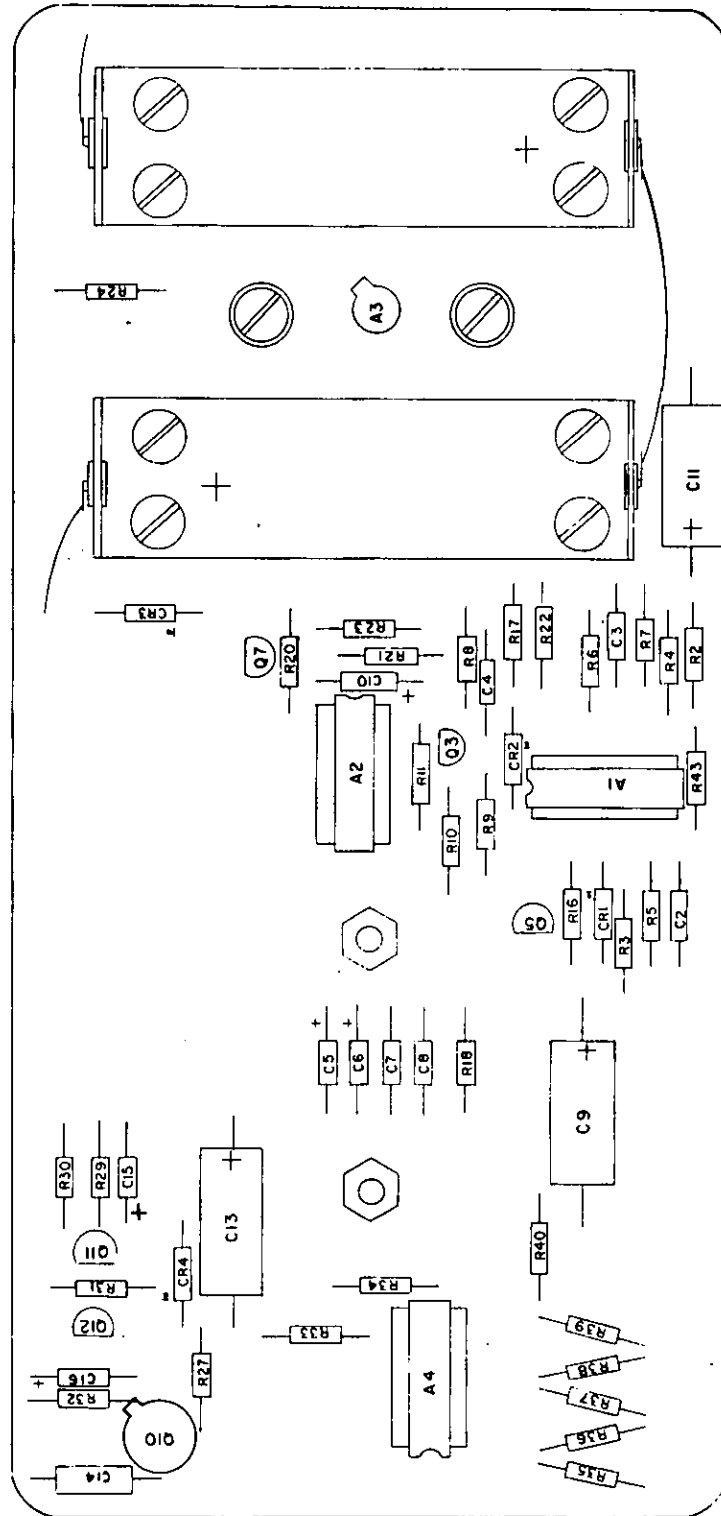


Figure 6-2. Component Assembly, Electronics Board, Sheet 1

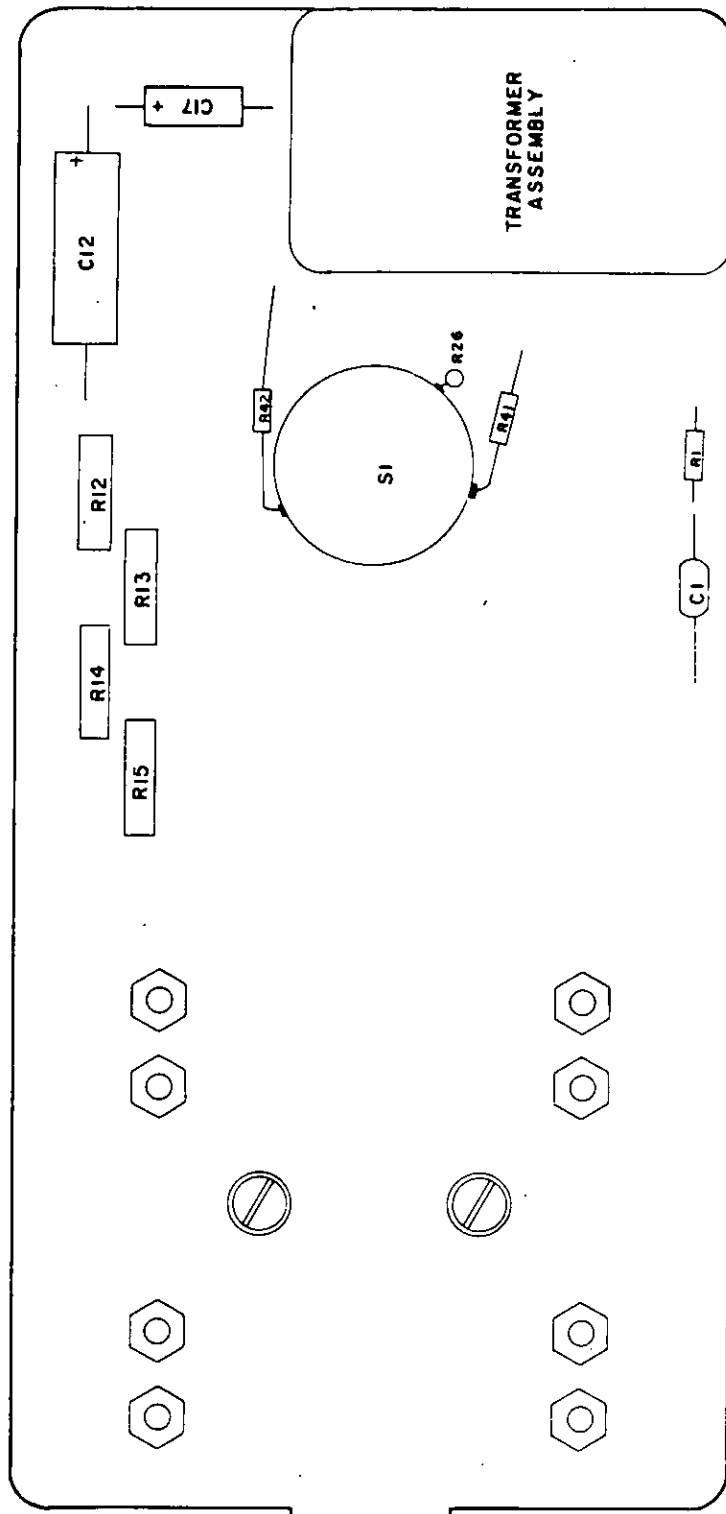


Figure 6-2. Component Assembly, Electronics Board, Sheet 2